Date: Wed, 1 Dec 93 04:30:29 PST
From: Ham-Homebrew Mailing List and Newsgroup <ham-homebrew@ucsd.edu>
Errors-To: Ham-Homebrew-Errors@UCSD.Edu
Reply-To: Ham-Homebrew@UCSD.Edu
Precedence: Bulk
Subject: Ham-Homebrew Digest V93 #119
To: Ham-Homebrew

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Today's Topics:
                              AM+FM=SSB?

Send Replies or notes for publication to: <Ham-Homebrew@UCSD.Edu>
Send subscription requests to: <Ham-Homebrew-REQUEST@UCSD.Edu>
Problems you can't solve otherwise to brian@ucsd.edu.

Archives of past issues of the Ham-Homebrew Digest are available
(by FTP only) from UCSD.Edu in directory "mailarchives/ham-homebrew".

We trust that readers are intelligent enough to realize that all text
herein consists of personal comments and does not represent the official
policies or positions of any party. Your mileage may vary. So there.

Date: Tue, 30 Nov 1993 02:56:48 GMT
From: munnari.oz.au!uniwa!harbinger.cc.monash.edu.au!yeshua.marcam.com!
news.kei.com!sol.ctr.columbia.edu!howland.reston.ans.net!cs.utexas.edu!asuvax!
ncar!csn!col.hp.com!srgenprp!alanb@network
Subject: AM+FM=SSB?
To: ham-homebrew@ucsd.edu

Mike Butts (mbutts@netcom.com) wrote:
: In the ARRL's "Solid State Design for the Radio
: Amateur", by Hayward and DeMaw, on p. 184 of
: the 1986 edition, after a nice summary of
: filter and phasing principles, plus a mention
: of Weaver, they say:

:   "Also, it may be shown mathematically that
:   a carrier which is amplitude modulated
:   properly and frequency modulated
:   simultaneously will yield a single-
:   sideband output."

: I haven't succeeded in figuring this out.
: Can someone show this mathematically or otherwise?

Assume the SSB signal is made up of a bunch of sine waves of different frequencies within the bandwidth of the SSB signal. You can combine any two of the sine waves to get a signal in the form of a modulated sine wave, with a different phase and frequency. For example, trig identities give:

```
sin(wt) + sin((w+delta)t) = 2 * cos((delta/2)t) * sin((w+delta/2)t)
                              ^^^^^^^^^^^^^^^^   ^^^^^^^^^^^^^^^^^
                              modulation          RF sine wave
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If the two sine waves have different frequencies or phases, the expression looks a litle different, but you still get a modulated sine wave.

If you combine two modulated sine waves, you get a third modulated sine wave, again at a different frequency and with more complex modulation. And so on with all the rest of the frequency components of the SSB signal. The result is that any SSB signal can be represented as a single sine wave with a varying frequency and amplitude.

In other words, the SSB signal can be broken up into two components: an amplitude modulation and a frequency/phase moculation. It is possible to separate the two and modulate them separately. The technique is to hard-limit the SSB signal, which leaves you with the FM component only. You than amplify this signal, using non-linear class-C amplifiers for efficiency, up to the output amplifier stage. The AM component is recovered from the original SSB signal with a diode envelope detector. It is amplified and used to AM-modulate the final amplifier. The result is the original SSB signal.

Note that both the FM modulation and the AM modulation have DC components, so the modulators must be DC-coupled throughout.

: Has it ever been done in a real system?

I understand it has been done. The complexity is not really worth the increase in efficiency, expecially when you add the expense of a high-level DC-coupled AM modulator.

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End of Ham-Homebrew Digest V93 #119
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